ATIP

AUTOMATED TRACK INSPECTION PROGRAM

UNITED STATES DEPARTMENT OF TRANSPORTATION
FEDERAL RAILROAD ADMINISTRATION
OFFICE OF SAFETY ASSURANCE AND COMPLIANCE

DEPARTMENT OF TRANSPORTATION
UNITED STATES OF AMERICA

2003 Edition

TRACK GEOMETRY MEASUREMENT FOR TODAY'S RAILROAD SYSTEMS

INTRODUCTION

The primary mission of the Federal Railroad Administration (FRA) is to ensure railroad safety. To accomplish this, we set and enforce safety standards, investigate major train accidents, and assist the rail industry in training its workforce on safety laws. To provide a balanced transportation system, the FRA Office of Safety Assurance and Compliance, is responsible for inspecting, monitoring and directing safety improvements at grade crossings, railroad trackage and railroad vehicles operating over the nation's general transportation system.

The national deployment of the Automated Track Inspection Program (ATIP), track geometry vehicle serves an important role in FRA's overall compliance programs. The Office of Safety objective is to conduct safe, accurate, and efficient surveys with the foci to develop a comprehensive automated inspection supplement that may eventually go beyond manual inspection imprecision by improving the method and practice of measuring substandard track conditions.

ATIP's function is to minimize the risk of a passenger or catastrophic hazardous material accident/incident by continuously improving the geometry vehicle's operational efficiency, insuring measured and recorded values accurately represent track conditions, and timely distributing track geometry information to FRA headquarters, regional management, and respective railroad personnel (Figure 1).

The primary safety-related use of ATIP is the assistance provided to FRA inspectors in identifying the most important track locations and conditions for them to evaluate. Key to ATIP's safety success is the advance detection of potential accident-causing hazards and the appropriate basis for inspectors to impose and safeguard rail transportation with compulsory operational and maintenance remediation.

FRA's track geometry survey vehicle (FRA T2000) helps America's railroads increase safety and keep pace with advancing technology. The data, produced by the car through the precise measurement of existing track systems, are used to monitor compliance with federal safety standards and aid in the efficient, effective track system maintenance planning to support the engineering of today's energy efficient, high speed railroads.

FRA relies on ATIP data as a primary tool for headquarter and regional managers to; (1) monitor and assess railroad compliance with the *Federal Track Safety Standards* (FTSS), (2) evaluate, as an early indicator of the safety trends within the industry, and (3) create a centralized Track Data Management System (TDMS) archive to support special safety studies, including accident/incident investigations, congressional, and public requests. Additionally, the TDMS database maybe used to set priorities for enforcement activities, compliance agreements, perform quality assurance checks for the geometry vehicle and to evaluate the effect of proposed changes in the FTSS.

The onboard measurement and geographic reference systems also make ATIP a valuable tool for the inventory of track structures (*e.g.*, turnouts, at grade railroad crossings and highway-rail crossing's locations), exception analyses, and convenient access to historical data for particular-surveyed railroad.

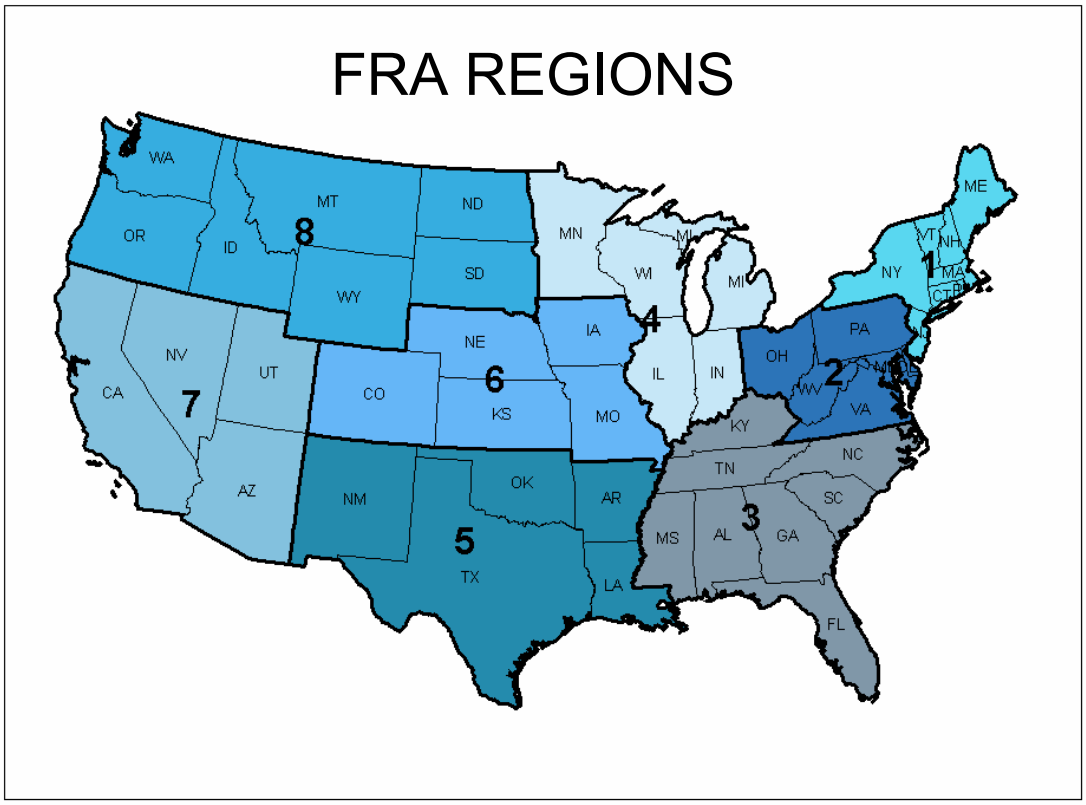


Figure 1

- FRA's T2000 vehicle is headquartered in Washington, DC. The Federal Railroad Administration, Office of Safety is responsible for the planning, direction and control of all aspects of the Automated Track Inspection Program.
- Surveys are scheduled according to current FRA priorities.
- Each of the eight regions assigns Federal Track Inspectors to the vehicle as it travels through the Region's Territory.
- State Track Inspectors augment the FRA team and inspect track within their respective states.

	Regional Office	Phone #	States in Region
Region 1	Cambridge, MA	(617) 494-3989	CT, ME, MA, NH, NJ, NY, PA, RI, VT
Region 2	Lester, PA	(610) 521-8200	DE, MD, NJ, OH, PA, VA, WV
Region 3	Atlanta, GA	(404) 562-3817	AL, FL, GA, KY, MS, NC, SC, TN
Region 4	Chicago, IL	(312) 353-6203	IL, IN, MI, MN, WI
Region 5	Hurst, TX	(817) 862-2200	AR, LA, NM, OK, TX
Region 6	Kansas City, MO	(816) 329-3840	CO, IA, IL, KS, MO, NE
Region 7	Sacramento, CA	(916) 498-6547	AZ, CA, NV, UT
Region 8	Vancouver, WA	(360) 696-7536	AK,ID, MT, OR, ND, SD, WA, WY

PRINCIPAL OPERATION

Safety onboard an FRA geometry vehicle and on the ground is of the utmost importance. Safe ATIP operations are the responsibility of FRA and contractor personnel, and, as such, they are held accountable for the control, authority, and enforcement of this policy. On behalf of the FRA, a contractor operates and maintains the government-furnished geometry vehicle safely efficiently, and accurately records track geometry data, performs the necessary adjustments towards corrective and preventive maintenance work, and all other activities required to keep the geometry vehicle's equipment and instrumentation in an operational, safe, clean, and orderly condition.

In addition, the contractor assures continuous quality improvement in service and technology to assist inspectors in fostering the identification and evaluation of geometry exception locations and conditions. A normal survey (testing) begins each day at 8:00 a.m. All assigned personnel will report promptly, at the designated on-duty time and location, to avoid a delayed departure.

Anywhere the geometry vehicle operates, onboard instrumentation always records track geometry measurements. Currently, an active survey status cycle consists of *four-weeks* of operations, (*i.e.,* Monday through Friday) followed by a weekend day to perform minor corrective or preventive maintenance and housekeeping, usually an 8-hour period. However, special assignment surveys maybe scheduled according to a specific occurrence and could last only a day or two in duration.

CLASS OF TRACK

The FTSS are contained in 49 Part 213 *Code of Federal Regulations* (CFR) and divide railroad track into nine (9) speed-related classifications, ranging up to 200 miles per hour. Permissible variations of track geometry are given for each track class. FRA delegates approximately 90 Federal track safety inspectors and 30 certified State inspectors, to monitor and assess railroad track compliance, and track owner maintenance records and safety procedures. The *Federal Track Safety Standards* are based upon authorized speeds for passenger and freight trains. When FRA and participating State Inspectors, inspect track for compliance [they] accept the introductory train speed information from the individual railroad. Consequently, this posted timetable speed establishes the basis for inspectors to view a track segment according to its design characteristics

FRA regulates train speed in two ways; the presence, or absence of a signal system and the physical and geometry condition or quality of the track structure. For example, regarding signal systems, if both passenger and freight trains were operated, FRA signal rules would limit the speed to 59 and 49 miles per hour, respectively, with no basic signal system in place. With a basic signal system in place, speed for all types of train equipment would be limited to 79 miles per hour.

FRA regulates railroads a second way by prescribing speed limits according to the specific geometry and physical track structure conditions existing in isolation. These minimum safety standards are often exceeded by railroads, which adopt more stringent safety requirements. Railroads are obligated to keep the track in compliance with the FTSS based on its design characteristics.

Geometry and structural tolerances specified in the FTSS are grouped (Table 1) according to a speed focused *'Class of Track'*. Deviation beyond the limiting parameters requires repair or reducing train speed to the appropriate 'class'. FRA regulations define nine (9) classes of track.

A segment of track must meet all of the requirements for its intended class, *i.e.*, geometry, crosstie and rail specifications, etc. Track classes are based upon maximum speed ranges of 10 through 200 miles per hour, that is, Class 1 track is the lowest speed upward to Class 9, and the highest speed trains are permitted to operate, respectively.

In other words, as train speed increases, track safety requirements become more restrictive. Train speed is only contingent upon the level of construction and maintenance a railroad places in its track toward a nationally uniform maximum limit. Through inspections, FRA and State safety inspectors daily ensure railroads are operating their trains according to the Federal regulations.

Class of Track: Operating Speed Limits Subpart A-F

Over track that meets all of the requirements prescribed in this part for…	The maximum allowable speed for freight trains is…	The maximum allowable speed for passenger trains is…
Excepted Track	10	Not applicable
Class 1 Track	10	15
Class 2 Track	25	30
Class 3 Track	40	60
Class 4 Track	60	80
Class 5 Track	80	90

Class of Track: Operating Speed Limits Subpart G

Over track that meets all of the requirements prescribed in this subpart for…	The maximum allowable operating speed for trains[1]
Class 6 Track	110
Class 7 Track	125
Class 8 Track	160[2]
Class 9 Track	200

Table 1

SURVEY EXCEPTIONS

Ideally, railroad tracks are perfectly uniform. In practice, however, weather and geographical conditions, train speeds, tonnage, and continued maintenance requirements contribute to railroad track non-uniformities and, in some cases, exceptions. FRA developed the high-speed track geometry vehicle FRA T2000 to detect non-uniformities and identify specific track conditions. When FRA T2000 measures track, sensors mounted on the vehicle generate electronic voltages. These voltages are collected at sample intervals of one foot, conditioned, and input to a data acquisition system.

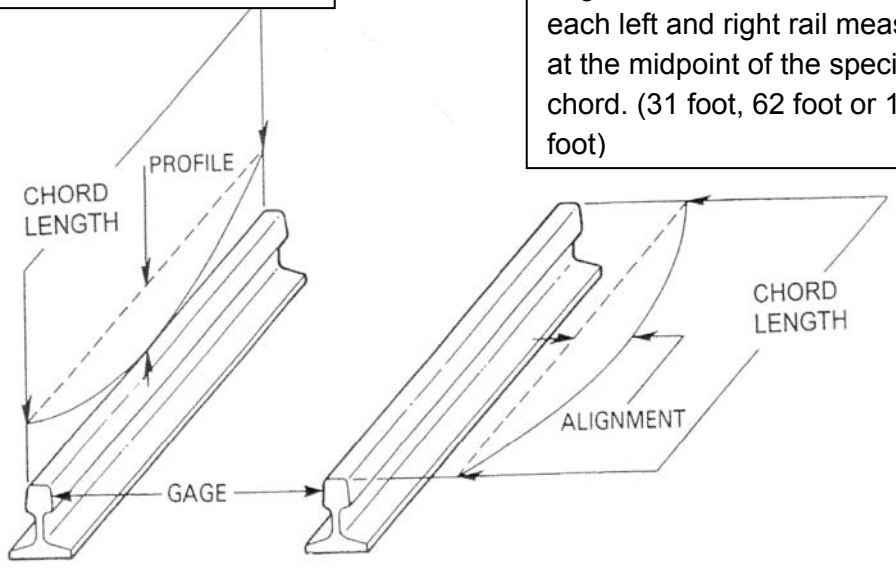
[1] Refer to §213.307 regulatory text
[2] Refer to §213.307 regulatory text

Track geometry parameter values are the product of complex calculations performed using variables (input voltages from instrumentation) and constant values. The products of these calculations represent information relating to the geometry of the track that can have positive or negative values or polarity. The data acquisition system consists of several networked microcomputers, equipped with analog-to-digital converters, disk drives, laser printers, and automatic and manual data entry devices. Several output devices are available including three oscillograph, video displays, and CD-ROM.

The data acquisition system processes the signals into track geometry parameters. Geometry parameters are compared to limits prescribed in the FTSS, which establish the maximum allowable speed for trains. The geometry vehicle's onboard TGMS instrumentation performs automated, analog signals, which are processed on-line by a computer and sustain a graphical record of detailed track geometry conditions, including delimiting measurements.

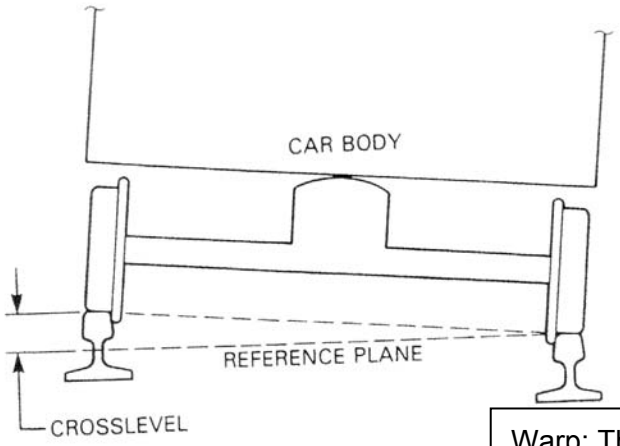
Profile: The surface uniformity of each left and right rail measured at the midpoint of the specified chord. (31 foot, 62 foot or 124 foot)

Alignment: The line uniformity of each left and right rail measured at the midpoint of the specified chord. (31 foot, 62 foot or 124 foot)



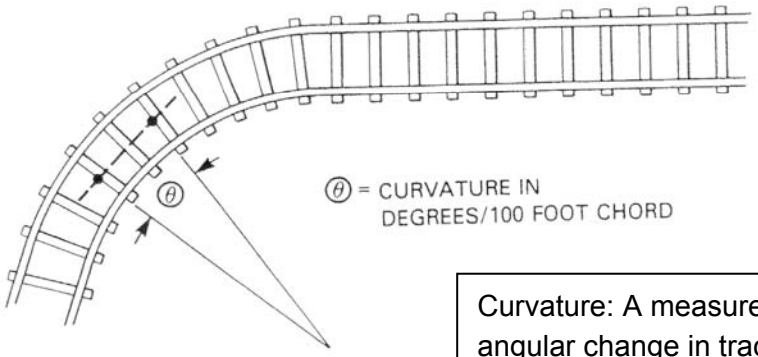
Gage: The distance between the rails measured five-eighths of an inch below the top surface of the rail.

Figure 2



Crosslevel: (Super-elevation) The amount of elevation of one rail above the other

Warp: The Deviation in Crosslevel between any two points less than 62 feet apart and derived from Crosslevel measurements. (Not illustrated)



Curvature: A measure of the angular change in track direction per 100-foot track chord.

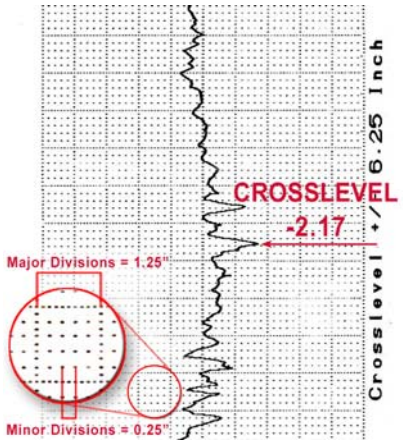
Rock-Off — A condition caused by regularly spaced, consecutive low joints. At low speeds, causes cars to rock. If severe can cause derailments by "Rocking Off" certain cars. Derived from Crosslevel. (Not illustrated)

Figure 3

DESCRIPTION OF PARAMETERS

The processor controls the data sampling of all analog and digital sensors required for track geometry measurements. Sensor outputs are combined by analog and digital calculations to arrive at the desired parameters. The track geometry processor also provides synchronization to all other time and distance based measurement systems. Track geometry measurement involves the following real-time track geometry parameter descriptions and operating requirements:

***Crosslevel*:** The system determines track crosslevel on tangent track and Superelevation on curved track by measuring the inclination angle of a loaded axle. The system first establishes the inclination of the car-body with a compensated accelerometer system (CAS). A CAS sensor package, consisting of an inclinometer, a fiber optic gyro (FOG) yaw and roll rate gyro, is mounted under the floor of the FRA T2000. Algorithms implemented in a combination of analog and digital schemes are used to process the CAS signals and yield the inclination of the car-body. Compensations are made to correct for the effects due to car speed, and centrifugal acceleration. Axle inclination is then computed by measuring the relative roll angle between the axle and the car-body.

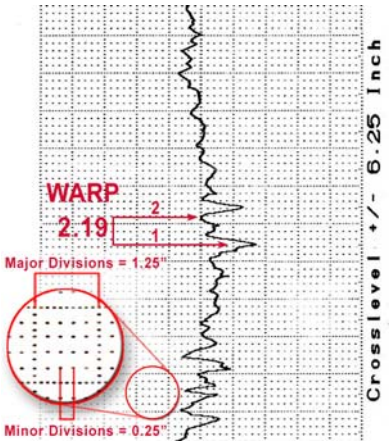


Crosslevel is then displayed on the 5th channel of the Astro-Med chart with a scale of ± 6.25 inches of elevation. A negative value indicate “left rail low” and a positive value indicates “right rail low”.

***Superelevation*:** A constant elevation of the outside rail over the inner rail must be maintained on curves as well as a uniform rate of change on spirals and is measured in the same manner as crosslevel.

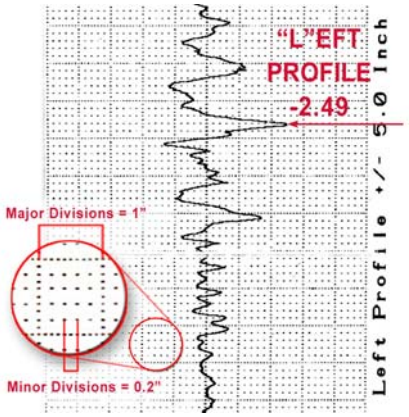
***Warp*:** Relates to crosslevel measured diagonally from one end of a rail car to the other. Low spots under opposite ends of the car are not desirable. Warp is the rate of change in crosslevel along the track and is the difference in crosslevel between any two points (tangent, spiral or curve) 62-feet apart or less and is measured in the same manner as crosslevel.

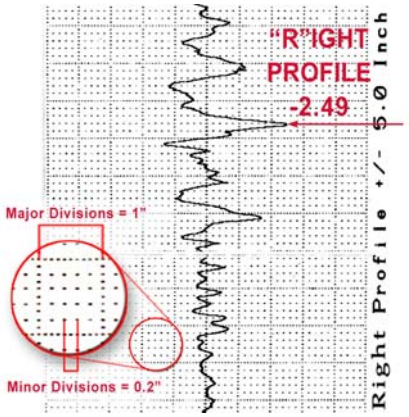
Warp is then displayed on the 5th channel with crosslevel and also has a scale of ± 6.25 inches.



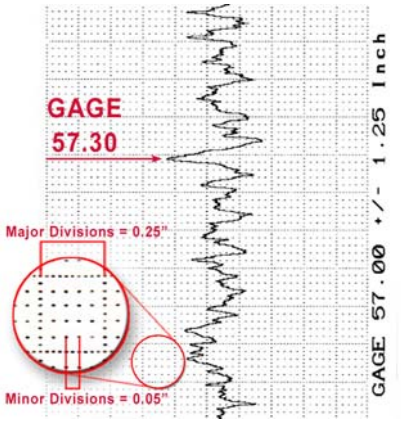
***Vertical** (Surface) Profile*: As crosslevel relates to transverse track elevation, profile relates to elevation along the longitudinal axis, that is, adherence to an established grade and the incidence of dips and humps. Profile of each rail is measured by the combination of two inertial accelerometers mounted vertically on the car-body and two vertical displacement measurements form the car-body to the axle. The signal from the accelerometers is processed to yield the up-and-down paths in space taken by the car floor. These paths are combined with the displacement measurements to form the vertical paths in space taken by the left and right wheels. Compensations for effects due to speed are made in software. The outputs can be represented in the form of a space curve or mid-chord offsets with respect to a selectable chord length.

Profile is then displayed on the 1st and 3rd channels of the Astro-Med chart with a scale of ± 5 inches of profile. A negative value indicates a "rail low" condition on a "dip". A positive value indicates a "rail high" condition on a "bump".





***Gage*:** The inside distance between the gage corners of the rails is measured ⅝-inches below the top of the rail by two separate systems. The primary gage system is a servo based laser gage system. The secondary system is vision based. The servo laser gage system is housed in a crossbeam that is mounted to the un-sprung part of the truck. The crossbeam, therefore, moves laterally with the wheel axle while maintaining a fixed height from the rail top. Two non-contact, laser sensors are mounted on the beam to measure the lateral distance from the beam to each rail. These laser sensors make non-contact distance measurements from a height of about three inches above the rail. As the vehicle travels along the track, the measurement beam moves laterally with the bogie. In order to keep the sensors within their range of linearity and high accuracy, each laser sensor assembly is mounted on an electro-mechanical servomechanism to keep the sensor at a fixed distance from the rail.

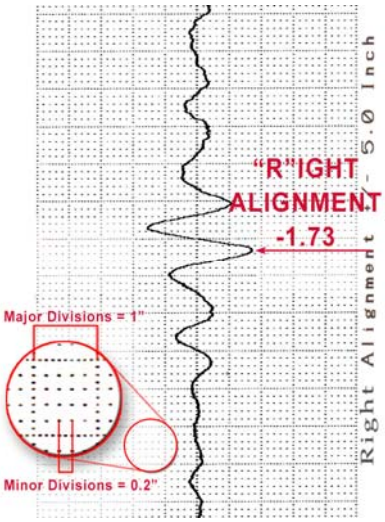


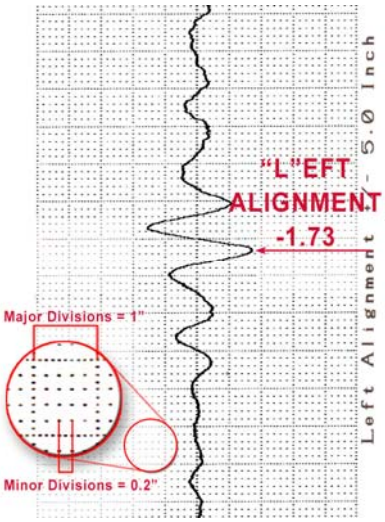
The position of each servomechanism is measured separately. The measured servo positions and the outputs of the two laser sensors are added to form the gage measurement. A Vision-Based High Speed Gage Measurement System (HSGMS) provides a second gage

measurement. The HSGMS system processes the image and provides the Track Geometry Measurement System (TGMS) a signal for left (LG) and right gage (RG). These signals are combined in the TGMS with the appropriate offset and scale factor to calculate gage. Gage is then displayed on the 7th channel of the Astro-Med chart displaying 55.75 inches to 58.25 inch

***Alignment*:** Alignment of each rail is measured by the combination of an inertial sensing system and the gage system. An inertial accelerometer is mounted laterally inside the measurement beam. The signal from the accelerometer is processed to yield the lateral path in space taken by the truck. Compensations for effects due to speed, truck roll, and curving are made in software. The path of the truck is combined with the left and right gage measurements to form the alignment of each individual rail. The outputs are provided in the form of a space curve and mid-chord offsets with multiple chord outputs are provided in the form of a space curve and mid-chord offsets with multiple chord lengths.

Alignment is then displayed on the 2nd and 4th channels of the Astro-Med with a scale factor of ± 5 inches.





***Curvature*:** The curvature measurement system determines track curvature by measuring the spatial rate of turn in the track. The system employs a rate-of-turn gyro to measure the temporal yaw rate. The temporal track yaw rate (in degrees per second) is converted to spatial track curving rate (in degrees per foot) by dividing train speed (in feet or meters per second) into it. Speed of the vehicle is provided by the speed and distance measurement system. The output of the curvature system, d = degree of curve, is scaled to a unit of degrees per 100 feet of track.

Runoff*:** A raise implies that during track maintenance, ***e.g., track tamping or shimming a bridge, the work increases the elevation of the track above an original level. Maintaining proper runoff in tangents and curves, because of increased dynamic vertical and lateral loading, is crucial. Trains riding on track runoff (or run on) will experience a vertical pitch[3] or bounce[4] if the runoff is too abrupt or short and is measured, based on a 31-foot chord, in the same manner as profile.

[3] Pitch of the carbody is the rotation about its transverse axis mass center.

[4] Bounce is the simple vertical oscillation of the body on its suspensions in which the car body remains horizontal.

PUTTING DATA TO USE

Track geometry data is simultaneously recorded on hard disk and CD-ROM format. Additional analysis can be performed to provide detailed information such as track geometry space curves, track quality indices, and other track geometry descriptors. This data is used to support FRA's effort to develop performance-based track geometry standards. Data is also displayed on an oscillograph for immediate viewing and processed in real-time to produce the Track Geometry Exception Report containing four (4) sections.

- Exception Summary Section (Mile by Mile Summary)
- Exception List Section (Detailed Exception Report)
- Curve Analysis Section (Detailed Curve Analysis)
- Excerpts from 49 CFR Part 213

These reports document the magnitude of any track exceptions, e.g., profile, crosslevel (Superelevation), warp, curvature, gage, and alignment. The detailed exception listings in this report provide FTSS information keyed to geographic location (i.e. distance from a milepost, or GPS latitude and longitude location). Federal and State Safety Inspectors use the reports as a tool to assess and insure compliance with Federal Track Safety Standards.

Railroad managers and maintenance planners use the reports to pinpoint sections of track that require maintenance, both short-range (days) and long-range (months) and to identify the types of maintenance actions required at specific locations, prepare work-crew schedules, and estimate future track maintenance workloads.

Examples

AUTOMATED TRACK INSPECTION PROGRAM
Exception List, Curve Analysis, and Exception Summary Reports

AUTOMATED TRACK INSPECTION PROGRAM				
EXCEPTION LIST REPORT				
Railroad Name				
Survey Number			**DATE: June 24, 2005**	
Location From:			**Milepost From:**	
Location To:			**Milepost To:**	

Milepost	+Feet	Parameter	Value	Length	TSC	L / P Class	Track	Latitude	Longitude
0	0	State Line							
0	2	Class Chg	1.00						
0	2	Track	1.00						
0	2	State Line	00						
0	3	Class Chg	4.00						
0	3	State Line	CA						
0	181	Class Chq	2.00						
0	512	Class Chg	3.00						
579	4411	Up MP	579.00						
579	1	Class Chg	4.00						
579	295	Class Chg	1 3.00						
579	1565	Class Chg	4.00						
580	5089	Up MP	580,00						
581	5444	Up MP	581.00						
582	5188	Up MP	582.00						
583	4790	Up MP	583.00						
583	204	Gage Wide	57.72	2	C	3 4	1		
583	436	Gage Wide	57.69	2	C	3 4	1		

EXCEPTION LIST REPORT

Column Heading	Description
MP	Milepost 4 digits Either Descending or Ascending
Feet	Feet Marked at End of Exception or at Manual Event. Negative Feet = Descending milepost. Feet at MP parameter = Footage between Mileposts
Parameter	See Parameter Entry List
Value	Most Restrictive Computed Value in Exception Integers expressed as X.00 (MP, Trk, Cls, etc.)
Length	Total Length of Exception
T-S-C	**T**angent, **S**piral, or **C**urve Track Segment
L / P Class	L = Limiting Class of Track P = Posted Track Classification (According to Speed)
Track	Track Number Using ATIP Convention (See Compliance Manual, Chapter 3)
Latitude	DGPS Latitude, Corrected by Dead Reckoning Feature
Longitude	DGPS Longitude, Corrected by Dead Reckoning Feature

Note: RQ = Ride Quality and RHL = Rail Head Loss Exceptions are advisory information only

AUTOMATED TRACK INSPECTION PROGRAM

CURVE ANALYSIS SUMMARY REPORT

Railroad Name

DATE: June 24, 2005

Survey Number:

Location FROM: **TO:** TRACK NUMBER:

LOCATION					AVERAGE				LIMITING PARAMETERS						LIMITING SPEED					
Starting		Ending		Total	Curve	Elevation	Speed		Location		Curve	Elevation	Total		Unbalance (Inches)					
MP	+Feet	MP	+Feet	Length	Deg/Min	Inches	Post	Limit	MP	Feet	Deg/Min	Inches	Feet	Grp	4	5	6	7	8	9
588	2184	588	3471	1287	2/31	2.82	50	56	588	2845	2/33	2.79	0	0	61	65	70	73	77	81
588	147	588	1338	1191	3/41	4.02	50	50	588	674	3139	3.58	0	0	54	57	61	64	67	70
588	4819	590	1892	2289	-1/27	-1.76	50	66	590	392	-1/28	-1,61	0	0	73	80	86	91	96	101
591	1613	591	3176	1563	-0/43	-0.74	65	81	591	2657	-0/47	-0.73	0	0	92	101	110	118	125	132
592	3593	593	467	2107	2/0	2.68	65	62	592	4350	2/1	2.60	1351	1	68	73	77	82	86	90
593	1690	593	4287	2597	-5/57	-2.75	30	36	593	2699	-5/59	-2.59	0	0	39	42	45	47	50	52
594	2752	594	5345	2560	-5/55	-2.75	60	36	594	3765	-5157	-2.56	1257	1	39	42	45	47	50	52
594	3892	594	1128	2459	1/31	1.81	60	63	594	541	1/31	1.34	0	0	70	77	83	88	93	98
596	3042	596	4797	1755	1/2	1.27	60	74	596	4143	1/6	1.26	0	0	82	90	97	103	109	115
597	265	597	1160	895	-0/54	-1.16	60	79	597	824	-0/55	-1.10	0	0	88	96	104	111	118	124
597	4541	598	526	1321	-1/56	-3.30	60	66	597	5173	-1/58	-3.20	0	0	72	77	81	85	90	94
598	1078	598	2884	1806	1/31	2.14	60	68	598	2154	1/34	2.17	0	0	74	80	86	91	96	100

CURVE ANALYSIS REPORT KEY

Column Heading	Description
Starting (MP) Milepost	Beginning Milepost of Curve
Starting (Dist) Distance	Beginning Feet of Curve
Ending MP	Ending Milepost of Curve
Ending Dist.	Ending Feet of Curve
Length	Total Length of Curve in Feet
Average Curv Deg/ Min	Average Curvature in Degrees/Minutes
Average Elev	Average Elevation in Inches
Speed Post	Posted Speed
Speed Lmt	Limiting Speed (Based on Entered Unbalance Value, Currently 3”)
Limiting Point MP	Milepost of Most Limiting Point
Limiting Point Feet	Foot Count from Recorded Milepost of Most Limiting Point
Limiting Point Curve Deg/Min	Curvature in Degrees /Minutes of Most Limiting Point
Limiting Point Elev Inches	Elevation in Inches of Most Limiting Point
Total Ft	Total Limiting Feet in Curve
Total Grp	Total of Limiting Groups of Limiting Points in Curve
Limiting Speed At 4	Speed Based upon 4-Inches of Unbalance
Limiting Speed At 5	Speed Based upon 5-Inches of Unbalance
Limiting Speed At 6	Speed Based upon 6-Inches of Unbalance
Limiting Speed At 7	Speed Based upon 7-Inches of Unbalance
Limiting Speed At 8	Speed Based upon 8-Inches of Unbalance
Limiting Speed At 9	Speed Based upon 9-Inches of Unbalance

Note: Positive (+) Negative (-) Values Under Warp, Crosslevel, Curvature, Profile And Alignment Headings--Relate To Left And Right Rails, Respectively, Determined By Vehicle Forward or Reverse Direction While Surveying. Crosslevel: Plus (+) = Left Rail High Minus (-) = Right Rail High **Curvature: Plus (+) = Curve to Right Minus (-) = Curve to Left**

AUTOMATED TRACK INSPECTION PROGRAM			
ONE MILE BY CLASS OF TRACK SUMMARY REPORT			
	Railroad Name		**DATE: June 24, 2005**
SURVEY NUMBER:			PAGE
LOCATION FROM:		**TO:**	
MILEPOST FROM			
MILEPOST To:			

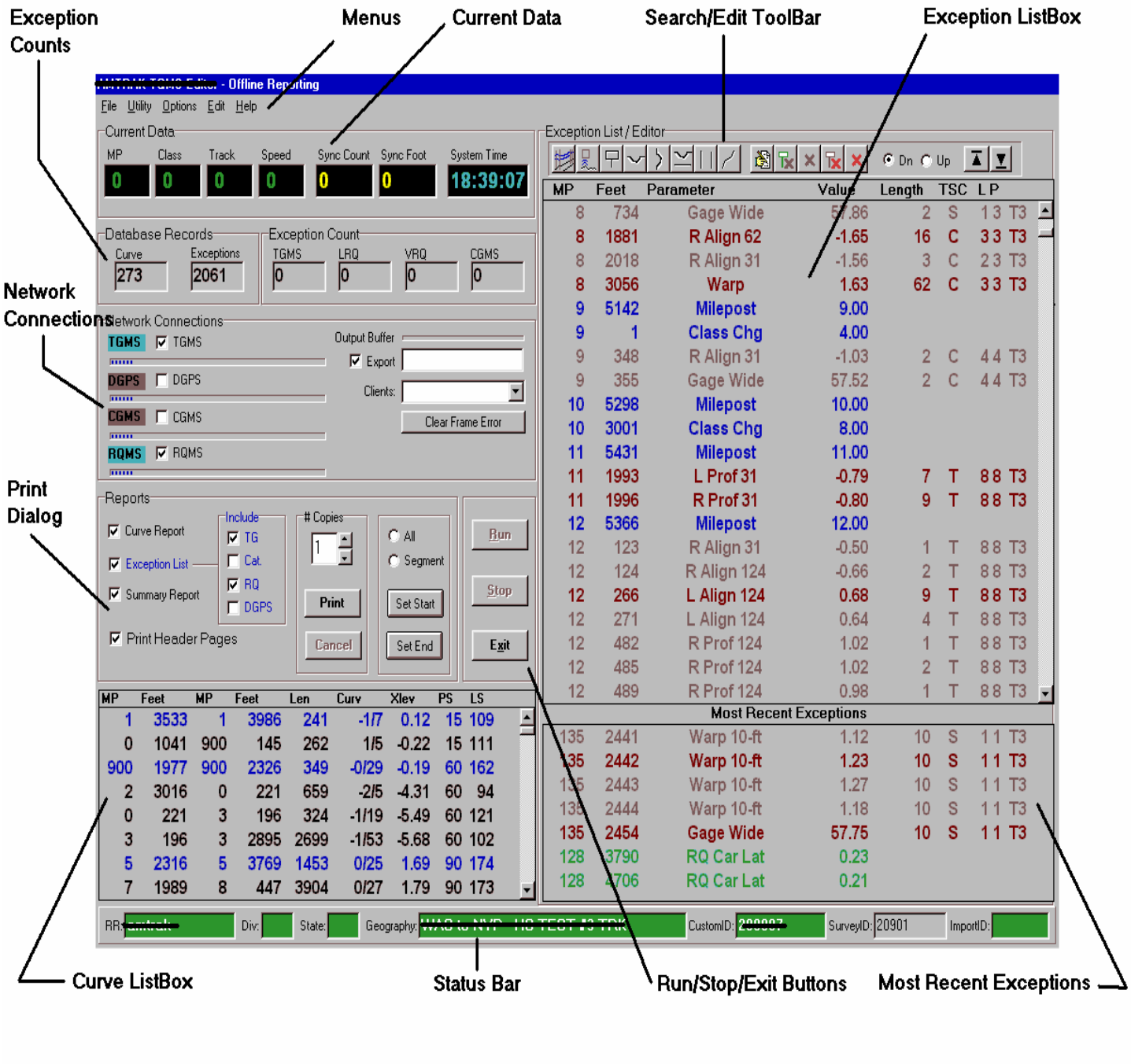
Location		Profile			Alignment			Gage			Crosslevel[5]			Warp			Classification		
Milepost	+FEET	Total Exception	Exception Feet	Class Exception	Total Exception	Exception Feet	Class Exception	Total Exception	Exception Feet	Class Exception	Total Exception	Exception Feet	Class Exception		Exception Feet	Class Exception	Limiting Class	Posted Class	Track #

ONE MILE BY CLASS OF TRACK SUMMARY REPORT KEY

Column Heading	Description
MP	Mile of Interest
FT	Total Foot Count of Mile
Profile Tot Exc	Total Profile Exceptions in Mile
Profile Exc Ft	Total Profile Exception Feet in Mile
Profile CL 1 Exc	Total Class 1 Profile Exceptions in Mile
Align Tot Exc	Total Alignment Exceptions in Mile
Align Exc Ft	Total Alignment Exception Feet in Mile
Align CL 1 Exc	Total Class 1 Alignment Exceptions in Mile
Gage Tot Exc	Total Gage Exceptions in Mile
Gage Exc Ft	Total Gage Exception Feet in Mile
Gage CL 1 Exc	Total Class 1 Gage Exceptions in Mile
Xlevel Tot Exc	Total Crosslevel Exceptions in Mile
Xlevel Exc Ft	Total Crosslevel Exception Feet in Mile
Xlev CL 1 Exc	Total Class 1 Crosslevel Exceptions in Mile
Warp Tot Exc	Total Warp Exceptions in Mile
Warp Exc Ft	Total Warp Exception Feet in Mile
Warp CL 1 Exc	Total Class 1 Warp Exceptions in Mile
Limit Class	Most Limiting Class in Mile
Posted Class	Posted Class in Mile or Mile Segment
Track	Track Number of Mile or Mile Segment

[5] Excess Elevation, Reverse Elevation, Runoff, And Rock Off Totals, Included In Crosslevel Heading.

EDITOR SCREEN DISPLAY



The Editor Screen allows the Track Inspector and Data Specialist to monitor system functions, curve data and track Geometry exceptions.

Excerpts from

UNITED STATES DEPARTMENT OF TRANSPORTATION
Federal Railroad Administration

49 CFR Part 213 Subpart A-F
Track Class 1 Through 5

And

49 CFR Part 213 Subpart G
Track Class 6 through 9

UNITED STATES DEPARTMENT OF TRANSPORTATION
Federal Railroad Administration
Excerpt from 49 CFR Part 213 Subpart A-F
Track Class 1 through Track Class 5

§ 213.53 Gage.

(a) Gage is measured between the heads of the rails at right angles to the rails in a plane five-eighths of an inch below the top of the railhead.

(b) Gage shall be within the limits prescribed in Table 3:

Class of Track	Must be at least	But not more than
Excepted	N/A	4 feet 10¼ -inches
Class 1	4-feet 8-inches	4 feet 10-inches
Class 2 and 3	4-feet 8-inches	4 feet 9¾ -inches
Class 4 and 5	4-feet 8-inches	4 feet 9½ -inches

Table 3

§ 213.55 Alignment.

Alignment may not deviate from uniformity more than the amount prescribed in Table 4:

Class of Track	Tangent Track	Curved Track	
	The deviation of the mid-offset from a 62- foot line may not be More than-(inches) Note 1	The deviation of the mid-ordinate from a 31-foot chord may not be more than- (inches) Note 2	The deviation of the mid-ordinate from a 62-foot chord may not be more than (inches) Note 2
Class 1 Track	5	Note 3	5
Class 2 Track	3	Note 3	3
Class 3 Track	1 ¾	1 ¼	1 ¾
Class 4 Track.	1 ½	1	1 ½
Class 5 Track	¾	½	⅝

Table 4

Notes: 1. The ends of the line shall be at points on the gage side of the line rail, five-eighths of an inch below the top of the railhead. Either rail may be used as the line rail; however, the same rail shall be used for the full length of that tangential segment of track.

2. The ends of the chord shall be at points on the gage side of the outer rail, five-eighths of an inch below the top of the railhead.

3. N/A-Not Applicable.

§ 213.57 Curves; elevation and speed limitations.

(a) The maximum crosslevel on the outside rail of a curve may not be more than 8 inches on track Classes 1 and 2 and 7 inches on Classes 3 through 5. Except as provided in § 213.63, the outside rail of a curve may not be lower than the inside rail.

(b) The maximum allowable operating speed for each curve is determined by the following formula:

$$V \text{ max } = -\sqrt{((Ea + 3)/(0.0007 * D))}$$

(c) For rolling stock meeting the requirements specified in paragraph (d) of this section, the maximum operating speed for each curve may be determined by the following formula:

$$V \text{ max } = -\sqrt{((Ea + 4)/(0.0007 * D))}$$

Where: V_{max} = Maximum allowable operating speed (miles per hour)
Ea = Actual elevation of the outside rail (inches)[6]
D = Degree of curvature (degrees).[7]

§ 213.59 Elevation of curved track; runoff.

(a) If a curve is elevated, the full elevation shall be provided throughout the curve, unless physical conditions do not permit. If elevation runoff occurs in a curve, the actual minimum elevation shall be used in computing the maximum allowable operating speed for that curve under § 213.57(b).

(b) Elevation runoff shall be at a uniform rate, within the limits of track surface deviation prescribed in §213.63 and it shall extend at least the full length of the spirals. If physical conditions do not permit a spiral long enough to accommodate the minimum length of runoff, part of the runoff may be on tangent track.

§ 213.63 Track surface.

Each owner of the track to which this part applies shall maintain the surface of its track within the limits prescribed in Table 5:

Track surface	Class of Track				
	1 (Inches)	2 (Inches)	3 (Inches)	4 (Inches)	5 (Inches)
The runoff in any 31 feet of rail at the end of a raise may not be more than	3 ½	3	2	1 ½	1
The deviation from uniform profile on either rail at the mid-ordinate of a 62-foot chord may not be more than.	3	2 ¾	2 ¼	2	1 ¼
The deviation from zero crosslevel at any point on tangent or reverse crosslevel elevation on curves may not be more than...	3	2	1 ¾	1 ¼	1
The difference in cross level between any two points less than 62 feet apart may not be more than [*, 1, 2] …	3	2 ¼	2	1 ¾	1 ½
* Where determined by engineering decision prior to the promulgation of this rule, due to physical restrictions on spiral length and operating practices and experience, the variation in crosslevel on spirals per 31 feet may not be more than …	2	1 ¾	1 ¼	1	¾

Notes:
[1] Except as limited by § 213.57(a), where the elevation at any point in a curve equals or exceeds 6 inches, the difference in crosslevel within 62 feet between that point and a point with greater elevation may not be more than 1-½ inches.

[2] However, to control harmonics on Class 2 through 5 jointed track with staggered joints, the crosslevel differences shall not exceed 1-¼ inches in all of six consecutive pairs of joints, as created by 7 low joints. Track with joints staggered less than 10 feet shall not be considered as having staggered joints. Joints within the 7 low joints outside of the regular joint spacing shall not be considered as joints for purposes of this footnote.

Table 5

[6] Actual elevation for each 155-foot track segment in the body of the curve is determined by averaging the elevation for 10 points through the segment at 15.5 foot spacing. If the curve length is less than 155-feet, average the points through the full length of the body of the curve.
[7] Degree of curvature is determined by averaging the degree of curvature over the same track segment as the elevation.

UNITED STATES DEPARTMENT OF TRANSPORTATION
Federal Railroad Administration
Excerpts from 49 CFR Part 213 Subpart G
Track Class 6 through Track Class 9

§ 213.323 Gage

(a) Gage is measured between the heads of the rails at right angles to the rails in a plane five-eighths of an inch below the top of the railhead.

(b) Gage shall be within the limits prescribed in Table 6:

Class of Track	Must be at least	but not more than	Change in 31 ft
6	4-feet 8-inches	4-feet 9¼-inches	½-inches
7	4-feet 8-inches	4-feet 9¼-inches	½-inches
8	4-feet 8-inches	4-feet 9¼-inches	½-inches
9	4-feet 8-inches	4-feet 9¼-inches	½-inches

Table 6

§ 213.327 Alignment

(a) Uniformity at any point along the track is established by averaging the measured mid-chord offset values for nine (9) consecutive points centered around that point and which are spaced according to Table 7:

Chord length	Spacing
31-feet	7-feet 9-inches
62-feet	15-feet 6-inches
124-feet	31-feet 0-inches

Table 7

(b) For a single deviation, alignment may not deviate from uniformity more than the amount prescribed in Table 8:

Class of track	The deviation from uniformity of the mid-chord offset for a 31-foot chord may not be more than (inches)	The deviation from uniformity of the mid-chord offset for a 62-foot chord may not be more than (inches)	The deviation from uniformity of the mid-chord offset for a 124-foot chord may not be more than (inches)
6	½	¾	1 ½
7	½	½	1 ¼
8	½	½	¾
9	½	½	¾

Table 8

(c) For three or more non-overlapping deviations from uniformity in track alignment occurring within a distance equal to five times the specified chord length, each of which exceeds the limits in the following table, each owner of the track to which this subpart applies shall maintain the alignment of the track within the limits prescribed for each deviation, as shown in Table 9:

Class of track	The deviation from uniformity of the mid- chord offset for a 31-foot chord may not be more than (inches)	The deviation from uniformity of the mid- chord offset for a 62-foot chord may not be more than (inches)	The deviation from uniformity of the mid-chord offset for a 124- foot chord may not be more than (inches)
6	⅜	½	1
7	⅜	⅜	⅞
8	⅜	⅜	½
9	⅜	⅜	½

Table 9

UNITED STATES DEPARTMENT OF TRANSPORTATION
Federal Railroad Administration
Excerpts from 49 CFR Part 213 Subpart G
Track Class 6 through Track Class 9

§ 213.329 Curves, elevation and speed limitations.

(a) The maximum crosslevel on the outside rail of a curve may not be more than 7 inches. The outside rail of a curve may not be more than ½ inch lower than the inside rail.

(b)(1) The maximum allowable operating speed for each curve is determined by the following formula:

(2) Appendix A (not included)

$$V\ \max\ = -\sqrt{((Ea + 3)\ /(0.0007\ *\ D))}$$

(c) For rolling stock meeting the requirements specified in paragraph (d) of this section, the maximum operating speed for each curve may be determined by the following formula:

$$V\ \max\ = -\sqrt{((Ea + Eu)\ /(0.0007\ *\ D))}$$

Where:

V_{max} = Maximum allowable operating speed (miles per hour)
E_a = Actual elevation of the outside rail (inches)[8]
E_u = Unbalanced elevation in (inches)
D = Degree of curvature (degrees).[9]
3 = 3-inches of unbalance

[8] Actual elevation for each 155-foot track segment in the body of the curve is determined by averaging the elevation for 10 points through the segment at 15.5 foot spacing. If the curve length is less than 155 feet, average the points through the full length of the body of the curve. If E_u exceeds 4-inches, the V_{max} formula applies to the spirals on both ends of the curve.

[9] Degree of curvature is determined by averaging the degree of curvature over the same track segment as the elevation.

§ 213.331 Track surface

1. For a single deviation in track surface, each owner of the track to which this subpart applies shall maintain the surface of its track within the limits prescribed in the following table

Track Surface (inches)	Class 6	Class 7	Class 8	Class 9
The deviation from uniform[10] profile on either rail at the mid-ordinate of a 31- foot chord may not be more than…	1	1	¾	½
I The deviation from uniform profile on either rail at the mid-ordinate of a 62-foot chord may not be more than…	1	1	1	¾
The deviation from uniform profile on either rail at the mid-ordinate of a 124-foot chord may not be more than…	1¾	1½	1¼	1¼
The difference in crosslevel between any two points less than 62 feet apart may not be more than[11] …	1½	1½	1½	1½

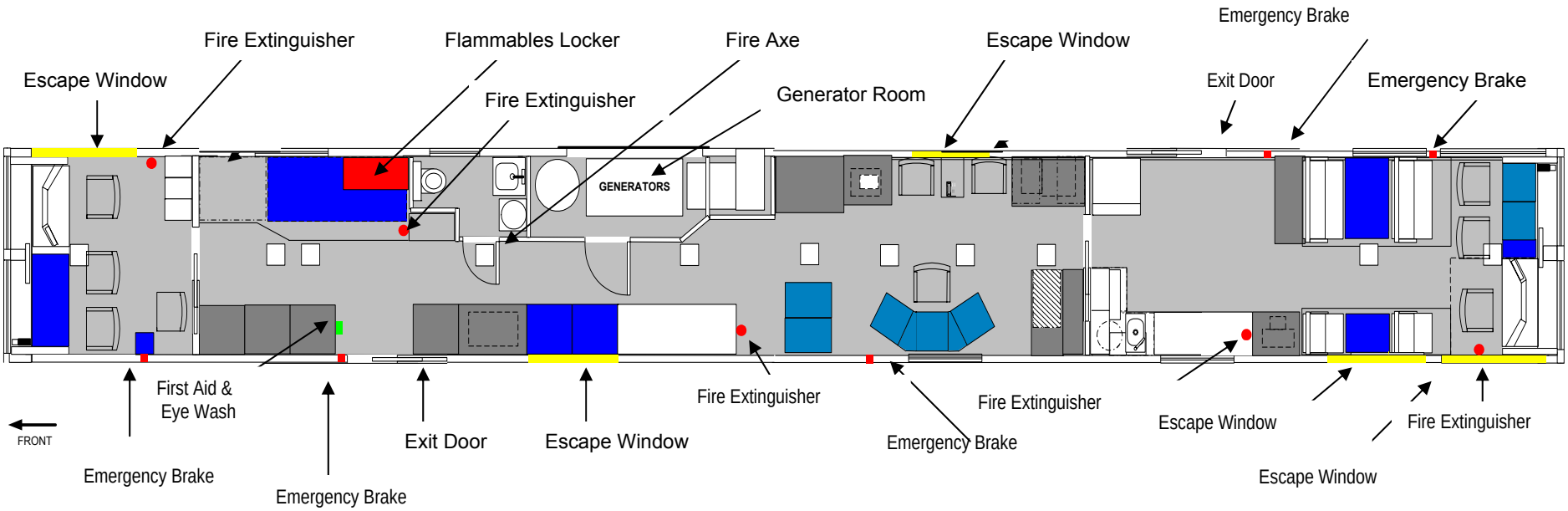
2. For three or more non-overlapping deviations in track surface occurring within a distance equal to five times the specific chord length, each of which exceeds the limits in the following table, each owner of the track…within the limits prescribed for each deviation:

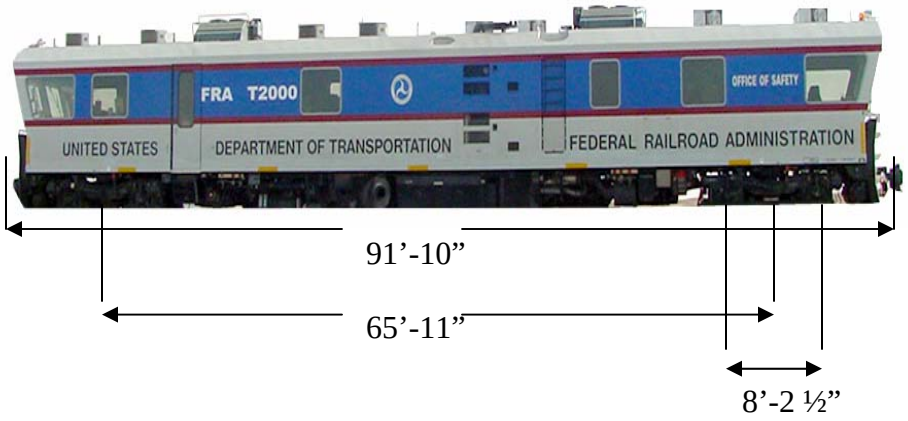
Track Surface (inches)	Class 6	Class 7	Class 8	Class 9
The deviation from uniform profile on either rail at the mid-ordinate of a 31-foot chord may not be more than…	¾	¾	½	⅜
The deviation from uniform profile on either rail at the mid-ordinate of a 62-foot chord may not be more than…	¾	¾	¾	½
The deviation from uniform profile on either rail at the mid-ordinate of a 124-foot chord may not be more than…	1 ¼	1	⅞	⅞

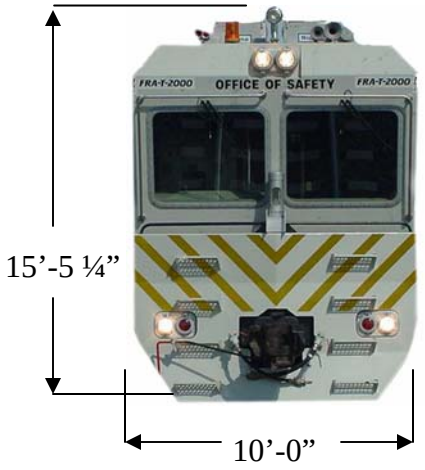
[10] Uniformity for profile is established by placing the midpoint of the specified chord at the point of maximum measurement

[11] However, to control harmonics on jointed track with staggered joints, the crosslevel differences shall not exceed 1-¼ inches in all of six consecutive pairs of joints, as created by 7 joints. Track with joints staggered less than 10-feet shall not be considered as having staggered joints. Joints within the 7 low joints outside of the regular joint spacing shall not be considered as joints.

FRA T2000 GEOMETRY VEHICLE SPECIFICATIONS







AUTOMATED TRACK INSPECTION PROGRAM

FRA T2000 VEHICLE SYSTEM

Type:	Self-Propelled Railcar (Specialized Maintenance Equipment) Compatible with AAR Interchange Rules
Brakes:	Knorr Disk Brakes with Anti-skid; Parking Brake with Manual Override, Capable **Service Brake Rate of 2.2 MPHPS, and an Emergency Rate of 2.8 MPHPS**
Communications	Internal Public Address System with External Jacks; Forward Observer's Control Console; Portable 'walkie-talkies' and Cellular Telephone, and (2) 100 Channel Clean Cab Radios.
Exception Marking	Paint Sprayer-External; DGPS Reporting; Strip chart scaling

DIMENSIONS AND WEIGHTS

Seating: Seating for 16 People (Including Engineer): Rear Observation (3); Kitchen (6); Computer Room (3); Forward Area (4)

Weight, w/ Fuel	**210,000 pounds (105 tons)**
Loading Each Axle	**26,250 pounds**
Length Over Pulling Force of Couplers (PFC)	**91' 10"**
Truck Center Distance	**65' 11"**
Truck Wheelbase	**8' 3"**
Maximum Length Carbody	**86' 11"**
Maximum Width Carbody	**10' 0"**
Maximum Height - Rail to Top of Air Conditioning Units, New Wheels, Light Car	**15' 5 ⅛"**
Height, Rail to Top of Finished Floor	**53 ⅜"**
Wheel Diameter (New)	**36"**
Fuel Capacity	**1050 U.S. gallons**

ACCOMMODATIONS

Communications:

Safety Equipment: First Aid Kits; Evacuation Tools; Escape Rope; Fire Extinguishers; Derails; Wheel Chocks; Blue Flags and Lights; Personal Protection Equipment (safety vests, eyewear, hard hat, breathing apparatus, steel-toed shoes, ***etc***.)

MISCELLANEOUS Flammable Stores Locker; Track Illumination Lights, (Rear) Instrumentation Illumination Lights Accommodations: Closets, six lockers

AUTOMATED TRACK INSPECTION PROGRAM
SUMMARY OF GEOMETRY VEHICLE MEASUREMENT CAPABILITIES

System	Measured Range	Speed Range (MPH)	Processing Mode		Laboratory Accuracy	Repeatability (inches)	
			Forward	Reverse		Mean	Standard Deviation
Distance (miles)	9,999.9 (optical)	0-110+	Yes	Yes	5 feet/mile	N/A	N/A
Speed	0-200 mph	0-110+	Yes	Yes	2% but not < 2mph	N/A	N/A
Location (ALD)	Magnetic	0-110+	Yes	**Yes**	100% Detection	N/A	N/A
Gage (normal rail Section)	55 ½ to 58 ½"	0-110+	Yes	Yes	1/32 Inch	1/32	1/16
Left or Right Curvature	± 20 Degrees	4-110+	Yes	Yes	0.2 Degrees/ 100' chord	0.01 Degrees/ 100' chord	0.15 Degrees/ 100' chord
Crosslevel	Up to 10 Inches	0-110+	Yes	Yes	1/16 Inch	1/32	1/16
Profile (Inertial)	± 5 inch	5-110+	Yes	Yes	1/16 Inch	1/32	1/16
Alignment	± 6.25 inch	15-110+	Yes	Yes	1/8 Inch	1/32	1/8
Warp	± 20 inch	4-110+	Yes	Yes	1/8 Inch	N/A	N/A
Limiting Speed	0-150 mph	4-110+	Yes	Yes	N/A	N/A	N/A
Ride Quality	± .25g	0-110+	Yes	Yes	1/64 g's	N/A	N/A
DGPS †	Long-360" Lat ± 90"	0-110+	Yes	Yes	3-10 Feet	N/A	5-Feet

Table 10

Notes: Worst-case repeatability characteristics based upon comparisons between 20 mph and 70 mph's tests in the same and opposite directions on Class 4 track from test sequence performed December 2000.

N/A = Not Applicable
† = Differential Global Positioning System

TYPICAL CREW COMPLEMENT

FRA inspectors are assigned to ensure compliance with applicable Federal and railroad rules. The primary purpose of this assignment activity is to assure the geometry vehicle is operated safely, in accordance with FRA policy, railroad operating rules, and that individual railroad track is being maintained, inspected, and complies with the FTSS

Each of FRA's eight regions is represented by a Track or Operating Practices (OP) inspector, onboard the geometry vehicle. Normally, the planned survey route is the assigned duty location and responsibility of the inspectors. The senior onboard FRA track inspector will be the final decision-making authority on the proper course of action for preparation and overall supervision of ATIP surveys. The senior onboard OP inspector will be the final decision-making authority on the proper course of action for the safe operational management of the vehicle.

FRA track inspectors are responsible for monitoring and assessing more than 190,000 railroad track miles. ATIP assists inspectors in meeting this responsibility and in so doing, requires the inspector to interpret and verify first-hand, the data collected and for relating FTSS exceptions to the surveyed track. The inspector is required to ride the geometry vehicle to permit real-time interpretation of analog, video, and printed outputs. This allows the track inspector to:

- Immediately discuss questionable track geometry exceptions with the onboard railroad representatives,
- Conduct manual on-the-ground inspections to verify measurable inputs,
- Insure proper and immediate remedial action is taken to halt or slow train operations on any portion of track containing a severe safety problem and,
- Observe track and right-of-way conditions (*e.g.,* vegetation obstructing visibility of signals and at highway-rail crossings) and detect FTSS exceptions not measured by the geometry vehicle measurement system.

The contractor assists both the FRA OP and Track inspectors in the monitoring of authorized speed accuracy according to reported track classification. Geometry vehicle speed will be monitored to indicate speedometer accuracy (timed checks) at suitable locations against all authorized timetable and track bulletin information, submitted by the railroad, as it applies to current track classification and related assigned speed values of authorized train movement.

RAILROAD REPRESENTATIVE

The Railroad Representative is usually someone with supervisory responsibility for track maintenance of the track being surveyed.

RAILROAD ENGINEER PILOT

The Locomotive Engineer Pilot is required to be certified and qualified on the physical characteristics of the track being surveyed.

CONTRACTOR EMPLOYEES

On behalf of the FRA, the contractor employees operate and maintain the government-furnished geometry car safely and efficiently, accurately record track geometry data, perform corrective and preventive maintenance work, make the necessary adjustments, and all activities required to keep the geometry car's equipment and instrumentation in an operational, safe, clean and orderly condition. The recommended number of personnel on the car during operations is sixteen.

SELF-PROPELLED FRA T2000 OPERATING INSTRUCTIONS

Federal Railroad Administration (FRA), Office of Safety, manages a railbound high-speed inspection vehicle (identified as FRA T2000) to measure track geometry for compliance with the *Federal Track Safety Standards* nationwide.

1) Each Train Dispatcher and Locomotive Engineer/Pilot will be furnished with a copy of this enclosure.

2) Prior to each day's survey, the contractor will conduct a face-to-face safety briefing to all occupants of the FRA T2000 and review applicable operational and safety conditions or on-track protection procedures. Proper equipment is onboard for signaling.

3) FRA inspectors, prior to the survey operation, will communicate directly with the train dispatcher and Locomotive Engineer/Pilot, to insure that all operating rules, in effect on the route to be traveled, are understood and confirm that the FRA T2000 will be dispatched as a train. Reference to applicable operating documents (Timetable, Special Instruction, General Order, Track Bulletin or similar documents) will confirm dispatching and operational information. FRA inspectors will be stationed in the immediate vicinity where the method of operation, procedures, and movement allows monitoring.

4) Whenever the FRA T2000 is operated, the railroad will assign and provide a Locomotive Engineer/Pilot, Traveling Engineer, or Road Foreman. The FRA T2000 Operator solely relies on the Locomotive Engineer/Pilot to identify a sufficient distance in advance, relevant railroad physical characteristics, movement authority limits, and authorized speeds. FRA T2000 is governed by applicable operating rules when moving on either signal or non-signal system territories (except that auto routing and automatic clearing features will not be used and all dual control switches will be blocked). Absolute block protection or alternate protection methods, controls or authority (except within "yard or restricted" limit territory require all trains operate at Restricted Speed), will be applied to protect FRA T2000 against opposing and following trains or on-track equipment.

5) The FRA T2000 operates as a train, and will not be operated by lineup, movement of track cars' or similar on-track equipment authorities. Authorization will not be issued within the same or overlapping limits of another train or on-track equipment, except to facilitate a disabled movement or emergency. Restricted Speed will govern movement within these limits according to the railroad's operating rules.

6) All mandatory directives will be transmitted and received in compliance with railroad rules and instructions. For purposes of this instruction, all references to assigned crewmembers apply only to the Locomotive Engineer/Pilot.

7) Interlocking machines will be operated manually for the FRA T2000 movement (automatic clearing and routing features will not be used). The control machine operator will be kept informed of the progress of the FRA T2000 from one control point to another. Interlocking control operators will not change the position of any switch or indication of any signal, until they are informed that the FRA T2000 is clear of the interlocking or a section thereof. Where provided, electrical or mechanical blocking devices will be used on switch and signal controls to protect against opposing and following movements. If the FRA T2000 is stopped within the limits of any interlocking, the control operator or dispatcher will be notified of the stop and the precise location. The FRA T2000 will not stop within the limits of an automatic interlocking or a non-interlocked, at grade railroad crossing.

8) In automatic block signal system or traffic control system territory, the FRA T2000 should not be stopped on sand or other similar rail surface conditions affecting the shunting of the track circuit. If such a stop cannot be avoided, the FRA T2000 will immediately move a sufficient distance to clear that affected portion of the rail. Track conditions may cause non-shunting. However, in all other conditions FRA T2000 has proven reliable and activates track circuits. Where provided, electrical or mechanical blocking devices will be used on switch and signal controls to protect against opposing and following movements.
9) FRA T2000 will approach all highway-rail grade crossings equipped with automatic warning devices prepared to stop, until it is determined the warning devices activate and the FRA T2000 occupies the crossing. On-ground protection against highway vehicles will be provided when automatic warning devices fail to fully activate, the FRA T2000 interferes with the normal function, or when prescribed by railroad rules or instructions.

10) FRA T2000 must not exceed the maximum passenger speed and are not restricted by special trackwork. In addition, the maximum operating speed of the FRA T2000 is 90 mph when self-propelled, and 110 mph when towed by a locomotive. FRA T2000 are not equipped with automatic cab signal, automatic train stop, or automatic train control systems and cannot negotiate curves greater than 20-degrees. Additionally, due to truck center length, the center of vehicle swing-out clearance is limited on curves greater than 13-degrees, and may restrict safe movement.

11) The FRA T2000 is equipped with operating controls at either end. When appropriate, instructions will be given to the operator to change and operate from the opposite end. Any reverse movement will be conducted, in accordance with the railroad's operating rules. FRA T2000 is not required to be stopped while being passed by a train on an adjacent track.

12) In the event the FRA T2000 Operator is to be relieved for any reason, the Locomotive Engineer/Pilot maybe utilized (if agreeable) to continue operations to the day's final tie-up point. If the Locomotive Engineer/Pilot is not willing or prohibited from operating the FRA T2000, the survey should be stopped at a suitable point short of the scheduled tie-up or a locomotive will be requisitioned for tow-in. This contingency is one that will be addressed at the beginning of the survey to allow for ample planning.

13) Neither FRA nor contractor employees will operate a railroad switch or derail and will rely upon a railroad employee to perform that function. After receiving authority for placement from the appropriate railroad representative, protective devices (*i.e.,* signs, derails, and locking devices, owned by FRA) will be applied by contractor employees. A 'blue signal' will be displayed on or near the FRA T2000, control stand at a readily visible location and the 'key' removed when on ground instrument verification (i-v's) checks are made. Similarly, positive protection (brakes placed in emergency position and surrendering of the locomotive reverser) will be imposed by FRA when a locomotive tows the FRA T2000.

14) Except within a locomotive servicing area or car shop area, FRA may reposition the FRA T2000 at anytime on a track or portion of a track that is exclusively occupied by the FRA T2000 and protected by FRA owned devices. Within a locomotive servicing area or car shop area, a railroad's blue signal rules will be in place and complied with to protect anyone on, under or at the ends of the FRA T2000. The FRA T2000 may be repositioned only after the movement is authorized by the railroad employee-in-charge of workers and approved by the FRA.

15) When unoccupied and at the request of FRA, FRA T2000 protection (guards) will be provided by the railroad. Additionally, the FRA T2000 will not be relocated or coupled to other rolling equipment without permission by the FRA. To prevent undesirable access, a remotely controlled or manually operated switch providing entrance to the track occupied by the FRA T2000, will be aligned against movement to that track. Where provided, electrical or mechanical blocking devices will be used on the switch and signal controls. Additionally, the switch will be secured with an effective locking device, exclusive to FRA. The switch stand's operating mechanism will be equipped with a visible all-weather display tag warning any users, "**Out of Service-Do Not Operate.**" At the request of the railroad, additional protective measures may be utilized.

    If a switch cannot be aligned and locked, as described, derails capable of restricting access will be used instead of an effective locking device. The placement[12] of front and rear "portable train control" signs will be displayed in the center of the track, marking the presence of the FRA T2000. The warning sign will consist; of a 16×24-inch red (flag) placard affixed to a derail signifying rolling equipment cannot couple or pass. An FRA T2000 wheel will be securely chocked to prohibit movement on its own.

[12] Protective devices, owned by FRA, will not be placed fewer than 150-feet from each end of the FRA T2000, except where appropriate.

ENSCO'S GENERAL SAFETY RULES

A. **Safety is the first consideration in the performance of your duty**

B. **Knowledge and obedience of the rules contained herein is essential to safety**

C. **ENSCO employees shall act in a professional and courteous manner at all times**

D. **In case of doubt or uncertainty in work procedures and practices, the safest course must be taken**

E. **Never assume that any safety device or procedure protects you, unless you have direct knowledge the device is in use or the procedure is being followed**

F. **ENSCO employees are required to have a copy of these rules while on duty and must understand and obey them. Questions regarding these rules shall be directed to the ENSCO Safety Officer or alternate for an explanation**

G. **The use of or being under the influence of intoxicants, narcotics, or dangerous drugs by ENSCO employees when on duty or when subject to duty, is prohibited. Possession of intoxicants, narcotics, or dangerous drugs or participation in any transaction involving the same by employees on duty or on Government or railroad property is prohibited and subject to disciplinary action, including dismissal. The use of any medication, including those prescribed or dispensed by physicians, that will affect an employee's alertness, coordination, reaction, judgment, vision, or ability to perform their work properly will be reported to the Safety Officer or alternate. Persons affected will be relieved of hazardous assignments**

H. **Everyone assigned to or visiting the survey cars must receive a safety briefing by the Survey Director or alternate, covering the rules or procedures that must be observed while on or about the survey vehicles**

I. **Any violation of these rules or any unsafe condition should be reported promptly to the Safety Officer or alternate**

J. **Employees who persist in unsafe practices and place themselves or others in jeopardy will be subject to disciplinary action, including dismissal**

K. **Employees must not rely solely upon the carefulness of others, but must protect themselves when their own safety is involved**

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Requests for further information on the use of these systems,
Or additional data related to the data collection techniques
Described, should be addressed to:

The Associate Administrator for Safety
Federal Railroad Administration
1120 Vermont Avenue NW
Washington, DC 20005

DEPARTMENT OF TRANSPORTATION
UNITED STATES OF AMERICA